CONTROLLING REGIONAL HAZE POLLUTION FROM THE OIL AND GAS SECTOR

Air pollution from oil and gas development, production, treatment, and transmission contributes significantly to regional haze at public lands like Carlsbad Caverns, Joshua Tree and Rocky Mountain national parks. Visibility impairing pollution from this sector includes nitrogen oxides (NOx), sulfur dioxide (SO_2), directly emitted particulate matter, volatile organic compounds (VOCs), and ammonia. Initially emitted as gases, these pollutants often convert into fine (i.e., less than 2.5 micrometers in diameter) particulate matter (PM) in the atmosphere, which scatter light, degrading visibility.

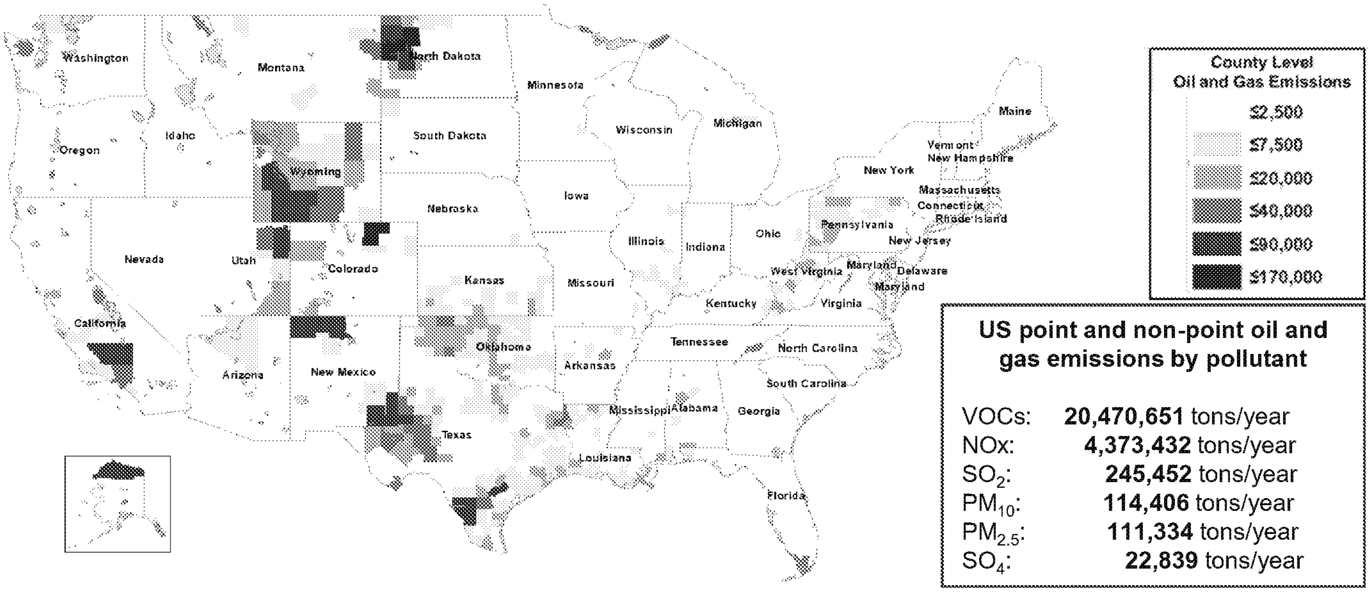
In order to reduce visibility impairing pollution and achieve the Clean Air Act mandate to restore clear skies at national parks and wilderness areas, federal and state agencies, and stakeholders need to work together to limit oil and gas pollution. States with oil and gas development and operations must reduce emissions from the different processes associated with the sector as part of their second round regional haze plans, due to EPA by July 2021.

This document summarizes NPCA recommendations for reasonable progress emissions controls[1] for the five primary emission sources of NOx, SO_2, PM, and VOCs associated with oil and gas development: gas and diesel fired reciprocating internal combustion engines (RICE); gas fired combustion turbines; heater and boilers; and flaring and thermal incineration of excess gas and waste gas. The controls included in this document represent options required on sources across the country.

2.8 BILLION
cubic feet of natural gas produced in North Dakota on a single day in early 2019, 20% of which was wasted through venting or flaring[2].

600%
increase in air pollution such as volatile organic compounds in the Permian Basin of Southeast New Mexico since 2011[3].

Visibility Impairing Emissions from the Oil and Gas Sector



US point and non-point oil and gas emissions by pollutant

VOCs:	**20,470,651** tons/year
NOx:	**4,373,432** tons/year
SO_2:	**245,452** tons/year
PM_{10}:	**114,406** tons/year
$PM_{2.5}$:	**111,334** tons/year
SO_4:	**22,839** tons/year

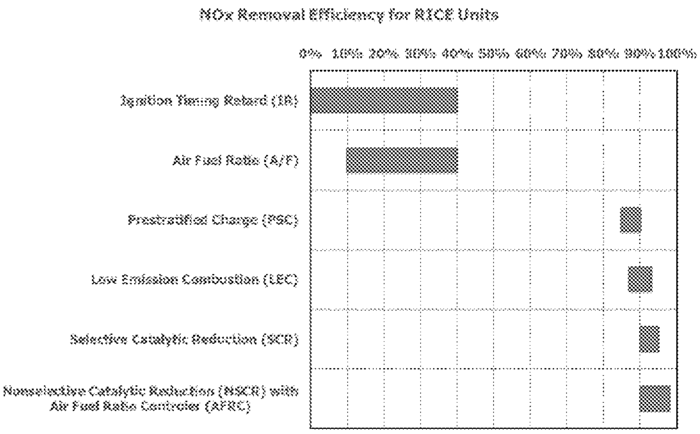
[1] The recommendations in this document are based on the report, "*Oil and Gas Sector Reasonable Progress Four-Factor Analysis for Five Source Categories*" prepared for NPCA by Vicki Stamper and Megan Williams.
[2] James MacPherson, "As North Dakota oil soars, so does waste of natural gas," Associated Press, May 27, 2019.
[3] Clean Air Task Force and Earthworks, "Country Living, Dirty Air: Oil and Gas Pollution in Rural America," July 2018.

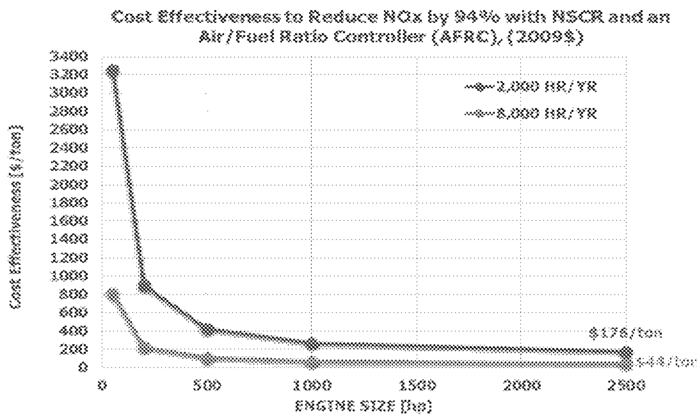
GAS-FIRED RECIPROCATING INTERNAL COMBUSTION ENGINES (RICE)

RICE units are one of the primary emission sources of NOx and VOCs in oil and gas development. RICE are used in a variety of applications, including gas compression, pumping, and power generation. These engines can operate **lean** (i.e., with a higher air-to-fuel ratio) or **rich** (i.e., with a lower air-to-fuel ratio).

Gas-fired RICE **electrification** is the recommended upgrade option to eliminate100% of NOx and other emissions from the engine. Replacement of reciprocating internal combustion engines with an electric motor can be cost effective for all size engines. Electrification is limited by the proximity of the engine to an electric power source. Where feasible, electrification also delivers reductions in methane, a highly potent greenhouse gas.

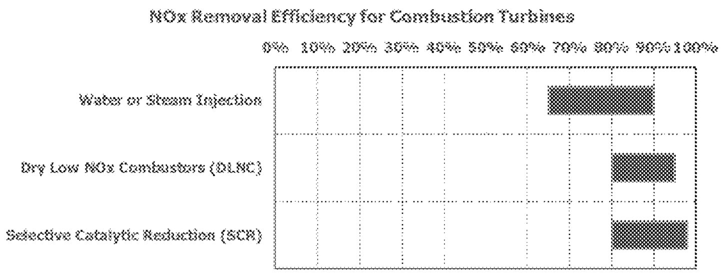
In addition to the electrification upgrade, there are different available controls to reduce NOx emissions from RICE units. According to NPCA's analysis, the best available and most cost-effective controls to reduce emissions from this source type are Nonselective Catalytic Reduction (NSCR) for rich burn units whereas Low Emission Combustion (LEC) and Selective Catalytic Reduction (SCR) are the best controls for lean burn units. In addition, for rich-burn RICE, NSCR is also the pollution control of choice to limit VOCs, as its three-way catalyst generally reduces NOx, CO, and VOCs.

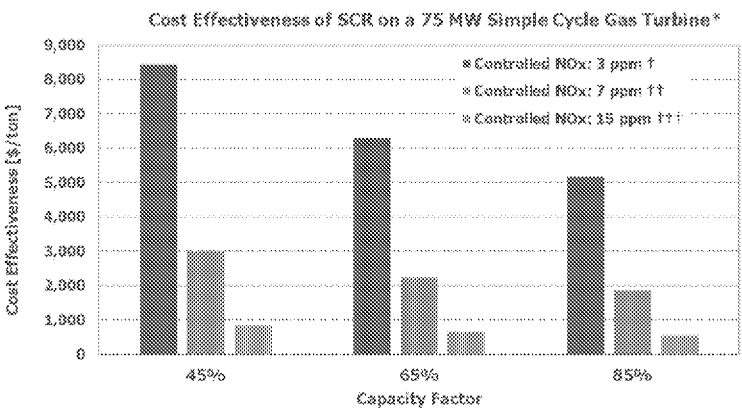




GAS-FIRED COMBUSTION TURBINES

Gas-fired **combustion turbines** are another primary source of visibility impairing emissions in the oil and gas industry. These turbines are used to provide on-site power to gas processing facilities, or they are used to drive compressors. There are several points in the oil and gas production process where compression of the gas is required to move the gas in the pipeline.





† Turbine with existing DLNC (80% control with SCR)
†† Turbine with existing water injection (83% control with SCR)
††† SCR at 90% control added to uncontrolled turbine
* The above analysis does not consider the combined control option of water injection or DLNC plus SCR, which would be more cost effective. Also note that costs of SCR are based on a 1999 gas turbine cost study, which continues to be relied upon by EPA in more recent cost reports.

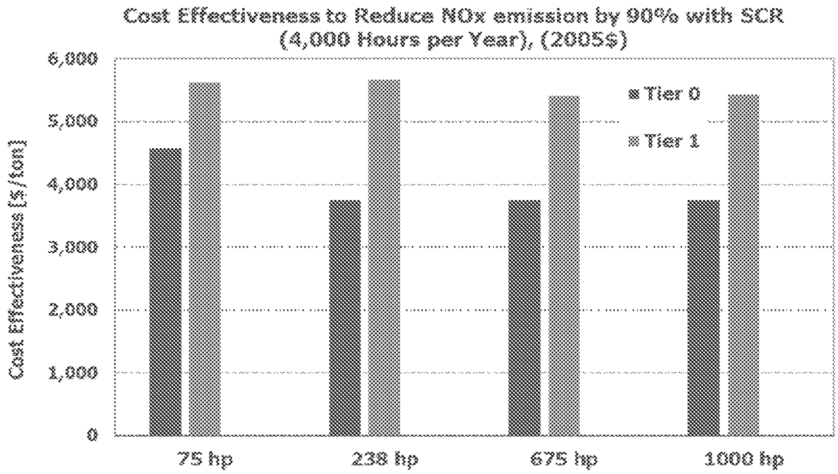
NPCA's analysis concludes that SCR is the top control and is cost effective for many gas turbines. DLNC is also cost effective and can achieve similar NOx rates as SCR for some turbine models. VOCs from turbines are most effectively reduced with oxidation catalysts.

DIESEL-FIRED RICE

Compression-ignited (i.e., diesel-fired) RICE are generally used in the oil and gas industry for on-site power generation, as well as to power or to drive drill rigs, drive hydraulic fracturing pumps, and to power other pumping and compression applications. Uncontrolled diesel RICE emit several pollutants that can contribute to regional haze, including NOx, PM, SO_2, and VOCs.

SCR and CDPF

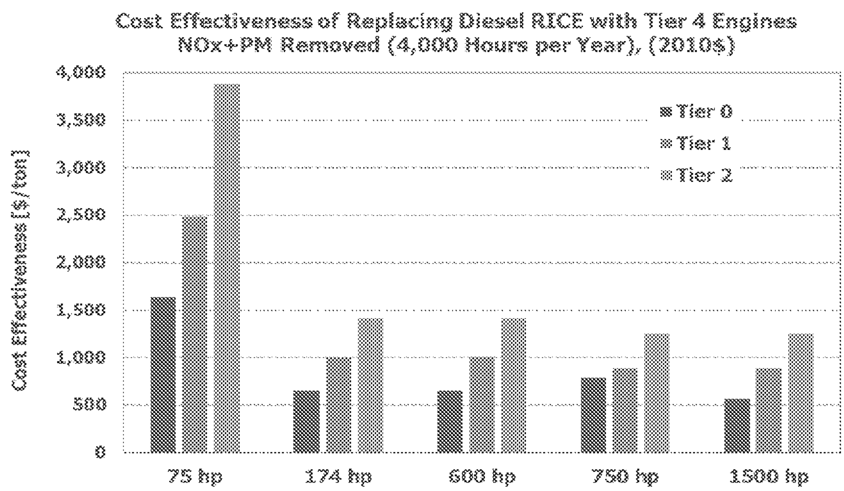
NOx emission from existing Tiers 0, 1, 2, and 3 diesel RICE engines can be reduced by up to **90%** using SCR while PM emission reductions using catalyzed diesel particle filters (CDPF) range from **85 to 97%.** Moreover, the CDPF filter can also reduce emissions of carbon monoxide (CO) and VOCs by 90%. Retrofitting SCR and CDPF on existing units is also cost effective, especially for existing Tiers 0, 1 and 2 diesel engines.



While any one of these pollution controls can be used at a diesel RICE to control one pollutant, the co-benefits of using these controls together (ULSD, CDPF, and SCR) ensures the most effective control of NOx, PM, SO_2, as well as CO and VOCs. Moreover, the use of **ultra-low sulfur diesel fuel (ULSD)** is essential in conjunction with exhaust treatment control technologies for reducing NOx and PM and is also, by itself, an effective and commonly applied way to reduce SO_2 emissions.

Replacement of Existing Diesel RICE with New, Lower Emitting Tier 4 Engines

Since 2015, EPA has required nonroad diesel engines be manufactured to meet Tier 4 emission standards, which reflect use of SCR and CDPF. Those Tier 4 standards reflect NOx reductions of **49% to 96%** and PM reductions of **81% to 97.5%** (smaller diesel engines and larger non-electric generating engines have less stringent emission standards). It is likely most cost effective to consider the replacement of existing engines with new Tier 4 engines rather than requiring retrofitting of pollution controls.



Replacement of Diesel RICE with Gas-Fired RICE

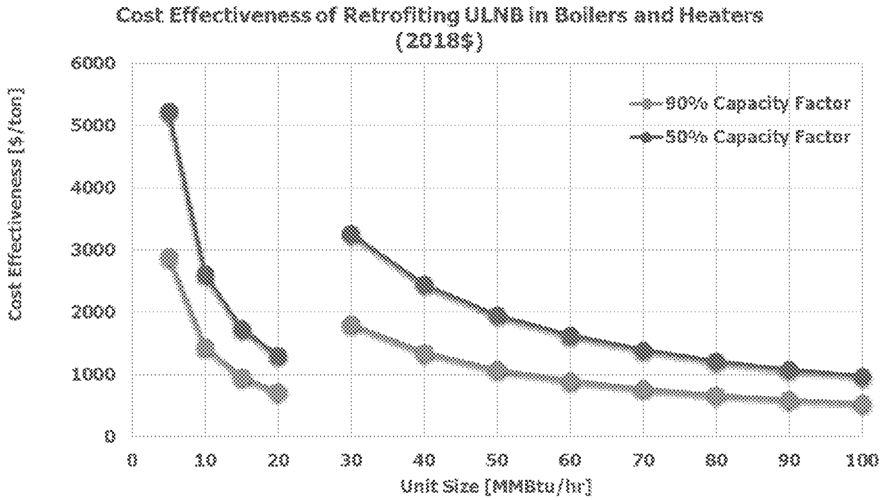
Another option for reducing emissions from diesel RICE is to replace the engines with gas-fired or dual fuel RICE. This would result in approximately a 91% reduction in NOx from use of Tier 0 diesel engines and approximately an 85% reduction in NOx from use of Tier 1 diesel engines. The use of gas-fired RICE instead of diesel RICE would also greatly reduce SO_2 and PM emissions.

NPCA recommends that states replace older engines with Tier 4 compliant engines and replace diesel drill rig engines with electric drill rig engines that are powered by Tier 4 generating set engines. These are the best options to cost effectively reduce emissions as reasonable progress measures for diesel RICE units. Where such replacement is not feasible, NPCA recommends replacing diesel engines with gas-fired RICE equipped with LEC or SCR to mitigate visibility-impairing pollution.

GAS-FIRED BOILERS, REBOILERS, AND HEATERS

Gas-fired boilers and heaters are used in a variety of applications, including power generation and the production of process heat and steam. In oil and gas production and processing, heaters can be used to aid in separation (e.g., heater-treaters, gas production units (GPUs), heated flash separator units), to maintain temperatures within pipes and connectors (e.g., line heaters), to maintain storage tank temperatures (e.g., tank heaters), and as regenerators and/or reboilers (e.g., dehydrators). Gas-fired external combustion units are sources of NOx, CO, VOC, and particulate matter emissions. SO_2 emissions may also occur if the field-gas used to fire the heaters contains hydrogen sulfide (H_2S), which converts to SO_2 during combustion.

Combustion modification—such as **flue gas recirculation (FGR)**, **low-NOx burners (LNB)**, and **ultra-low NOx burners (ULNB)**—reduce NOx formation by controlling the combustion process. NOx emission reductions of **40 to 85%** can be achieved using low NOx burners. When low NOx burners and FGR are used in combination NOx emission reductions of **60 to 90%** can be achieved. The chart on the right shows the cost effectiveness of retrofitting ultra-low NOx burners to meet a NOx limit of 6 ppm at boilers and heaters. For smaller heaters, replacement with heaters equipped with state-of-the-art low NOx technology can be cost effective as well.



SCR systems are post-combustion controls that can be used on gas heaters and boilers which can achieve NOx removal efficiencies in the range of **80 to 90+%** and are cost effective for larger units. **Selective Non-Catalytic Reduction (SNCR)** is also a post-combustion control option that can achieve **30-75%** NOx reduction.

Additionally, NOx emission can be reduced by **lowering combustion temperatures in heater-treaters**.

While controls and combustion modifications are efficient to remove NOx and are cost-effective, NPCA recommends the **centralization of gas well gathering facilities** to reduce NOx emissions from wellhead separation sources. Removing individual heater-treaters and replacing them with a central gathering facility would eliminate emissions from the individual heater-treaters. The central gathering facility would be a new source of emissions; however, overall emissions will be reduced. Not only would combustion emissions from the multiple heater-treaters be eliminated, but VOC emissions from condensate tanks would also be removed.

FLARING AND THERMAL INCINERATION

Gas flaring is a process to combust excess or waste gases from oil wells, gas processing plants, or oil refineries. It is intended as a means of disposal of excess gas as a safety measure and is also done to relieve pressure in gas pipelines. A thermal incinerator is a thermal oxidation process that occurs in an enclosed combustion chamber. The purpose of both a flare and a thermal incinerator is to combust the excess or waste gas and reduce VOC emissions.

For those facilities for which flaring is the only option, it is imperative that the flares be operated in accordance with EPA's New Source Performance Standards (NSPS) and EPA's National Emission Standards for Hazardous Air Pollutants (NESHAPs) requirements, and that the flares are operated and maintained in accordance with their design. To ensure these requirements are being met and that flaring is minimized to the maximum extent possible, the state or local air agencies must conduct thorough oversight into the causes of flaring episodes, to ensure that the facility is being maintained and operated in a manner to minimize all flaring episodes to the extent possible.

NPCA recommends prevention of flaring through **the collection of excess gas** as the most beneficial option for reducing visibility impairing pollution as well as greenhouse gases. Moreover, **thermal incineration** should be considered in lieu of flaring for waste gases due to the pollution controls for NOx and SO_2 that are available and because of the improved operation and VOC destruction.

Please contact Daniel Orozco at dorozco@npca.org for more information including the full report supporting these recommendations.